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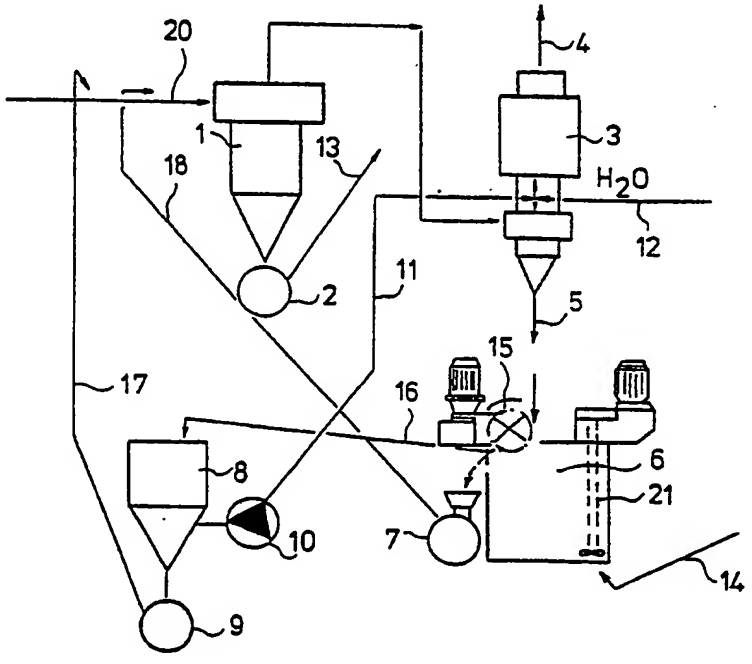

(57) Abstract

A wet washing procedure wherein the reaction products, in the first place the sulphur dioxide which has burned with use of lime, react to become Ca-sulphite. This is best oxidized with air. The oxidized gypsum is flotated with oxidizing air in a reaction tank (6) and the foam is conducted either into the combustion volume of the combustion boiler or to join the hot flue gases (20) to be purified, whereby liquid emissions are inhibited. The gypsum that has joined the quick ash is separated in a dry separator (1) in dry condition, and possibly a minor part of the quick ash goes once again to the washing, into the liquid and to flotation, and thence further to drying.

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Flue-gas purifying procedure

The present invention concerns a flue-gas purifying procedure conforming to the introductory part of claim 1.

The nature-polluting effect of the sulphur content in flue gases is nowadays recognized, in Central Europe in particular, to be a highly troublesome phenomenon. In industrial emissions, for instance, sulphur is burned to sulphur dioxide, and the gaseous sulphur dioxide reacts with moisture to become sulphurous acid and sulphuric acid. Sulphurous acid and sulphuric SALTS, in turn, being strong acids, react with metal and basic metal or minerals in the soil, and these impurities cause acidification of the soil and depletion of trace elements in the nature.

Research aiming at removal of the detrimental sulphur in flue gases has been going on for quite a long time, and numerous designs have been worked out in order to reduce these harmful flue gas emissions. It is nowadays generally recognized that electric filtering of flue gases alone is not enough. On the other hand, addition of milk of lime, or $Ca(OH)_2$, into the flue gas volume has been found to produce comparatively good results. This application of milk of lime is the so-called semi-dry method. It implies that a milk of lime spray is dried with the flue gases, whereat the sulphur dioxide is bound in powder form, and this powder is separated from the flue gases. The drawback of this procedure of prior art is the high cost of the method and the use of a relatively high excess of lime, or so-called over-stoichiometry, in relation to the sulphur, which results in comparatively large quantities of waste product.

Also known in the art is the so-called floating bed burning method, in which $CaCO_3$ powder is supplied, together with coal powder, into the burning furnace, in which with a powerful air current these

materials are maintained in the air current floating in the conical part of the furnace. In this procedure of prior art, the coal burns and the limestone is converted to the compound CaO, which in its turn reacts directly with the sulphur which was present in the coal and has burned. This method is encumbered by the drawback of its relatively high cost and of large so-called circulating solid matter flows.

In prior art one has also used the so-called wet washing method to the purpose of purifying flue gases: in this method the flue gases are directly washed with alkaline washing water. This procedure of prior art is comparatively reliable, and it is possible in this method to come very close to stoichiometry = 1. The drawbacks of the procedure consist of numerous harmful effects, such as frequent plugging, corrosion, wear phenomena and, in particular, large water quantities, their collection and conveying to dumps having caused major difficulties.

The object of the invention is to achieve an improvement of the flue gas purifying methods known at present. The more detailed object of the invention is to achieve an improvement of the wet washing method presently known. The other objects of the invention and the advantages gainable by its aid will become apparent in the disclosure of the invention.

The procedure of the invention is mainly characterized by that which is stated in the characteristic features part of claim 1.

The procedure of the invention is simple as to its principle, and a closed design is employed in it. As taught by the invention, flotation of the liquid emerging from the wet washer and of the solid matter therein to become separate partial flows, which are easy to dry, is a simple but genial insight. When the procedure of the invention is applied, the washing fluid quantities above all, and also the sizes of the tanks required in the apparatus design, are reduced to a fraction of those involved in any presently used

procedure. It is possible in an advantageous embodiment of the invention to recover the impurities carried in the whole flue gas quantity, in dry condition and even in chemically bound state without even the slightest aqueous emission.

The invention shall now be described in detail, referring to the principle design presented in the figure of the attached drawing, to which however the invention is not meant to be exclusively confined.

The figure of the drawing presents an advantageous embodiment of the apparatus design employed in implementing the procedure of the invention, in schematic elevational view.

In the embodiment depicted in the figure, the flue gas flow 20 is first conducted, advantageously, into a dry separator 1, which in this embodiment is a conventional cyclone separator. Part of the impurities present in the flue gases depart from the flue gas flow 20 and run down into the lower cone of the cyclone separator 1, whence the dry solid matter may be conducted, with the aid of a pressure transmitter 2 located below the cyclone separator 1, as a material flow 13 e.g. to a centralized powdery material storage container (not depicted).

After the cyclone separator 1, the flue gases flow to the wet washer 3, where the gaseous components present in the flue gases are washed so that the gas flow 4 emerging from the wet washer 3 will be clean enough. The wet washer 3 is known in the art in itself and it may be combined with the cyclone separator, as has been shown in the figure of the drawing. The washing water flows along the line 12 of the wet washer 3. The spent washing water flows from the wet washer 3 to a combined mixing and flotation unit 6, in the form of the washing water flow 5.

Air is conducted to the mixing and flotation unit 6 by the line 14, and the mixing and flotation unit 6 is advantageously provided

with a mixing means 21. In the mixing and flotation unit 6, the sulphite in the washing water, if any, is oxidized to sulphate, and the flotation process taking place lifts the reaction and washing products that have been formed in the wet washer 3, along with the foam out from the mixing and flotation unit 6. Such a foam remover has been indicated with the reference numeral 15 in the figure of the drawing. The foam, with the solid matter and the liquid held in the foam, is directed to a pressure transmitter 7 which has been disposed to guide the separated foam as a flow 18 to join the flue gas flow 20, the flue gas flow 20 having been arranged to dry out the liquid held in the foam and, as the flue gas temperature usually is in the range of 100 to 240°C, the $CaSO_4$ loses part of its crystal water. The dried solid matter separates and ends up among the solid matter in the lower cone of the cyclone separator 1, in which connection for instance the separated gypsum is in the form of a powder hardening powerfully together with water and thus is a substance well appropriate to be carried to a dump, or to be used otherwise. If desired, facilities for adding flocculating agent can be provided on the mixing and flotation unit 6, or a flocculation unit alone may be substituted for this unit, depending on what chemicals are used.

The solid matter which fails to be removed from the mixing and flotation unit 6 runs as an overflow 16 into the tank 8, where advantageously with the aid of centrifugal action the solid matter is directed to settle in the lower cone of the tank 8. Below the lower cone of the tank 8 has been disposed a pressure transmitter 9, arranged to direct this solid matter in a flow 17 to join the flue gas flow 20, whereby the liquid held by the solid matter evaporates off and the solid matter separates in dry dust form in the lower part of the cyclone separator 1, whence the pressure transmitter 2 sends the dry solid matter as a material flow 13 to the centralized powdery material storage already described.

Certain practical facts have to be observed when applying the procedure of the invention. When the fuel, coal in the first place,

contains 1% sulphur, the quantity of gypsum that has to be dried in the procedure of the invention will be 3.5 to 5% of the coal, depending on the purity of the lime that is used. The solid matter passing through the dry separation varies between 1 and 3% of the quantity of coal burned, and therefore the quantity of solid matter that has to be dried varies between 4 and 8% of the coal quantity. This, together with the washing liquid that has to be evaporated, lowers the temperature of the flue gas flow 20 by about 10 to 30°, depending on the liquid quantity in the material to be dried.

It is also possible in the procedure of the invention to direct the material flow 17 directly into the combustion boiler, where naturally the material flow is heated to a temperature at which the gypsum totally loses its crystal water and becomes either slow-reacting with water or becomes so-called "dead"-gypsum, which reacts hardly at all with water. It should be noted, on the other hand, that the gypsum is again decomposed to sulphur dioxide, and for this reason it is not recommended that the material flow 17 be conducted into the combustion boiler, at least not into its hottest region.

The washing liquid flow 12 contains the requisite neutralizing substance, in which capacity $Ca(OH)_2$, or so-called milk of lime, serves best. The quantity of milk of lime in the washing liquid is advantageously monitored so that the mixing and flotation unit 6 can operate in a pH range of preferably 5 to 9. Naturally, other chemicals may be used instead of milk of lime, for instance NaOH, or caustic liquor, or $NaCO_3$, or soda, in which case the sulphur present in the flue gas flow 20 will react without forming any solid products. In that case nothing emerges from the mixing and flotation unit 6 but the quick ash that has passed through the cyclone separator 1.

The material flows 17 and 18 dried in the incoming flue gas flow 20 are separated in the cyclone separator 1 mainly in granulated form. It should be particularly noted that the size both of the

mixing and flotation unit 6 and the tank 8 is comparatively small compared with the liquid tanks in present use. In the procedure of the invention, the requirement of fresh washing water, in terms of weight, is on the order of the coal quantity (the fuel quantity) that is fed in.

It is also possible in the procedure of the invention to recover heat from the washing liquid. An advantageous way to accomplish such recovery is to arrange for a return flow 11 from the tank 8 to the wet washer 3, e.g. by means of a water circulating pump 10. It should be noted that, as a rule, the temperature in the tank varies: for instance in connection with coal firing, between 40 and 60°C. The return flow 11 also flushes out impurities from the wet washer 3 because the return flow joins the washing liquid flow 5, which is directed to the mixing and flotation unit 6. It is thus possible in the procedure of the invention to achieve a so-called closed washing liquid circulation.

Claims

1. A procedure for purifying flue gases, wherein the flue gas flow (20) containing impurities is conducted into a washer means (3), to which is conducted washing liquid containing chemicals, such as advantageously $Ca(OH)_2$, said washing liquid having been disposed to react with the flue gas flow (20) to be purified, characterized in that the washing liquid which has reacted with the flue gas flow (20) to be purified is conducted to a combined mixing and flotation unit (6), and that the foam emerging from said mixing and flotation unit (6) together with its solid matter and with the liquid held in the foam is conducted as a first flow (18) to join the flue gas flow (20) to be purified or directly into the combustion volume of the combustion boiler, the flue gas flow (20) to be purified having been disposed to dry out the liquid contained in the foam.

2. Procedure according to claim 1, characterized in that the solid matter which fails to leave said mixing and flotation unit (6) has been disposed to go as an overflow (16) to a tank (8), where the solid matter is separated to lodge in the lower part of said tank (8), and that the separated solid matter is directed as a second flow (17) to join the flue gas flow (20) to be purified or possibly directly into the combustion volume of the combustion boiler, whereby the liquid held by the solid matter evaporates off.

3. Procedure according to claim 1 or 2, characterized in that the flue gas flow (20) to be purified is prior to its flowing to the washer means (3) conducted to a dry separator (1), where the dry solid matter contained in the flue gas flow (20) separates.

4. Procedure according to claim 3, characterized in that the flows (17,18) conducted to join the flue gas flow (20) to be purified in order to be dried are conducted to said dry separator (1), where the solid matter contained in said flows (17,18) has been arranged to become separated to join the dry solid matter contained in the

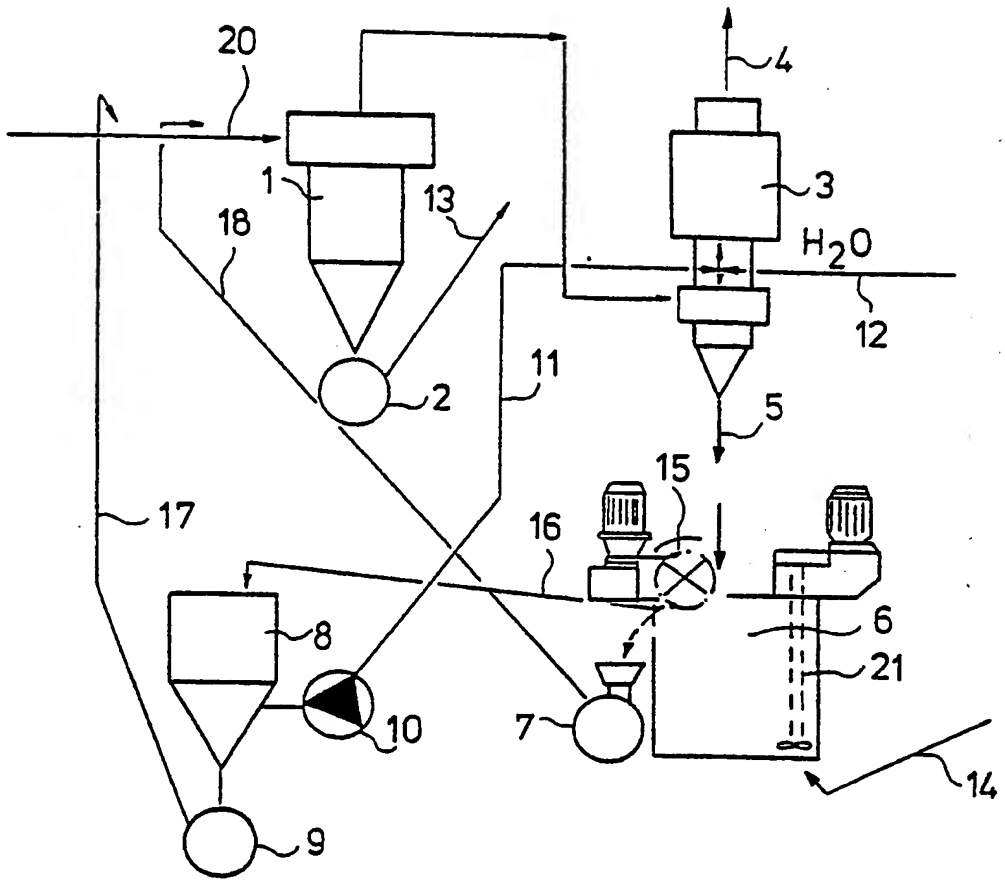
flue gas flow (20) to be purified.

5. Procedure according to claim 3 or 4, characterized in that the dry solid matter that has separated to lodge in the lower part of the dry separator (1) is conducted as a material flow (13) to a centralized powdery material store.

6. Procedure according to any one of claims 1-5, characterized in that the pH range of the mixing and flotation unit (6) is controlled to keep within a suitable flotation range, preferably in the range from 5 to 9, with the aid of a suitable alkali.

7. Procedure according to any one of claims 1-6, characterized in that the spent washing liquid is conducted as a return flow (11) back to said washer means (3).

8. Procedure according to claim 7, characterized in that the spent washing liquid is pumped from said tank (8) with the aid of a circulation pump (10) to constitute a return flow to the washer means (3), the heat contained in the washing fluid being recovered at the same time.


20
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H_2O
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INTERNATIONAL SEARCH REPORT

International Application No PCT/FI86/00027

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

B 01 D 53/14

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	B 01 D 53/14, /34; C 01 F 11/46
US Cl	423:242, 555

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	SE, B, 396 363 (B P B INDUSTRIES LTD) 19 September 1977	
A	EP, A1, 108 249 (STEAG AG) 16 May 1984	
A	US, A, 4 294 807 (RANDOLPH) 13 October 1981	
X	GB, A, 1 401 682 (FISONS LIMITED) 30 July 1975	1

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